

# **Australia's First Geosequestration Demonstration - The CO2CRC Otway Basin Pilot Project**

**6<sup>th</sup> Annual Conference on Carbon Capture and Sequestration  
Pittsburgh , May 10, 2007**

Sandeep Sharma<sup>1'2</sup>, Peter Cook<sup>1</sup>

<sup>1</sup> Cooperative Research Centre for Greenhouse Gas Technologies, Canberra,  
ACT 2601, Australia.

<sup>2</sup> Schlumberger Australia, Pty. Ltd., Perth, WA 6000, Australia.



# Acknowledgements

- CO2CRC Colleagues
  - P. Cook, A. Rigg, B. Hooper, J. Kaldi, D. Hilditch, T. Berly, P. Steele, C. Anderson, C. Peacock, D. Neal, L. Shepherd and others
  - G&G and Reservoir team: L. Spencer, L. Paterson, J. Xu, D. Sherlock, E. Perkins, P. van Ruth, R. Causebrook, T. Dance and others
  - M&V team (K.Dodds, M.Urosovich, D.Etheridge, A. Kepic, P. Wisman, B. Evans, M. Watson, E. Perkins, R. Leuning) and others
- CO2CRC supporting companies : Woodside, BHP Billiton, Rio Tinto, Anglo Coal, Schlumberger, Solid Energy, Xstrata Coal, Chevron, Shell, BP, CanSyd, Process Group and others.
- Government colleagues from ITR, EPA, AGO, DPI, DSE, Moyne Shire, SRW
- International Collaborators: LBNL, ARC, BEG, reviewers and other advisors
- Management of CO2CRC and Schlumberger Oilfield Services

# Outline

- CO2CRC
- The Otway Basin Pilot Project
- Project Concept
- Technical and Non-Technical Challenges
- Monitoring and Verification
- Community Consultation
- Forward Plans

# CO2CRC Participants:

Capture

Storage

Pilot Projects



RIO  
TINTO



**Australian Government**

**Geoscience Australia**

**Australian Greenhouse Office**

**Department of Industry, Tourism and Resources**



**SOLID ENERGY**  
Coals of New Zealand



**ACARP**

Australian Coal Association Research Program



**curtin**  
University of Technology  
Western Australia



**ANGLO  
COAL**

**Schlumberger**



**MONASH University**



**UNSW**



**THE UNIVERSITY OF  
MELBOURNE**



**WOODSIDE  
AUSTRALIAN ENERGY**

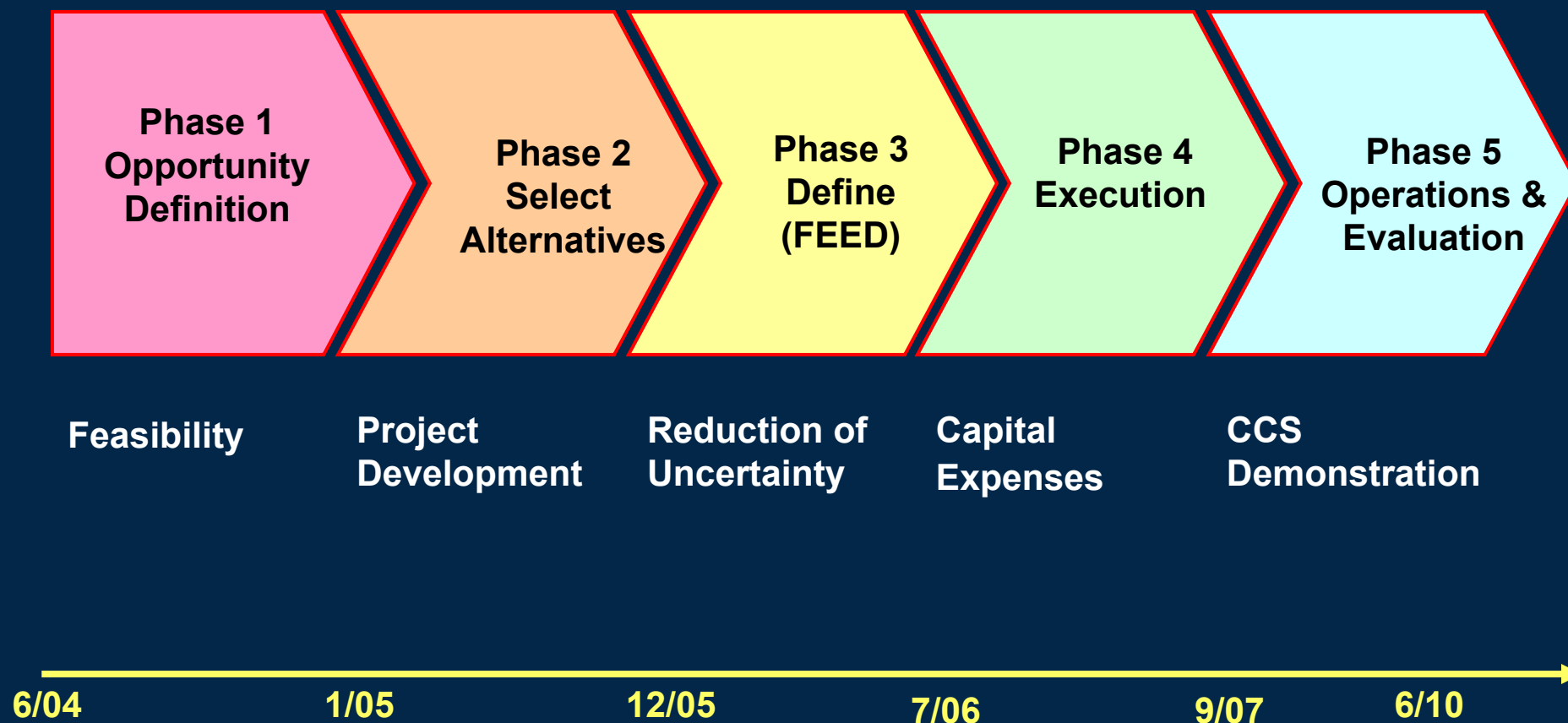


Supporting participants: **Australian National University** | **CANSYD** | **Meiji University** |  
**The Process Group** | **University of Queensland** | **Whistler Research** |

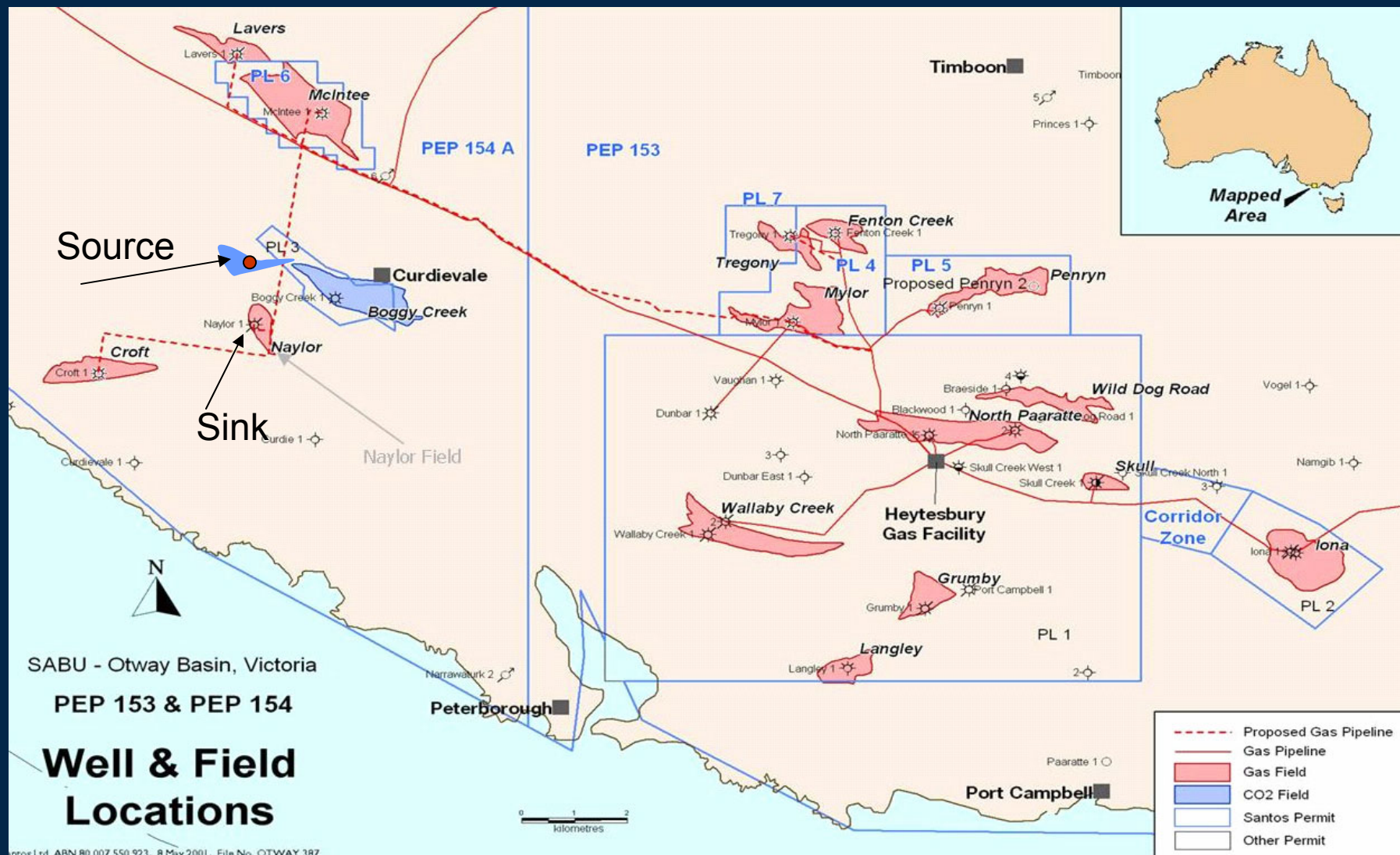
# Otway Basin Pilot Project (OBPP) Goals

- **Contribute towards CO2CRC Vision and Mission.**
  - Demonstrate that CCS is technically feasible and environmentally safe.
  - Facilitate research into new monitoring technologies
  - Offer opportunities for trial and experimentation thereby supporting education/training in greenhouse gas technologies.
- **Specifically demonstrate to the satisfaction of stakeholders that**
  - CO<sub>2</sub> can be **safely produced, transported and injected** into the sub-surface
  - CO<sub>2</sub> can be **safely stored**
  - **Subsurface behaviour** of the injected CO<sub>2</sub> can be effectively **modeled and monitored**
  - Storage Volume can be verified as far as possible
  - **Build public support for CCS** as a mitigation mechanism

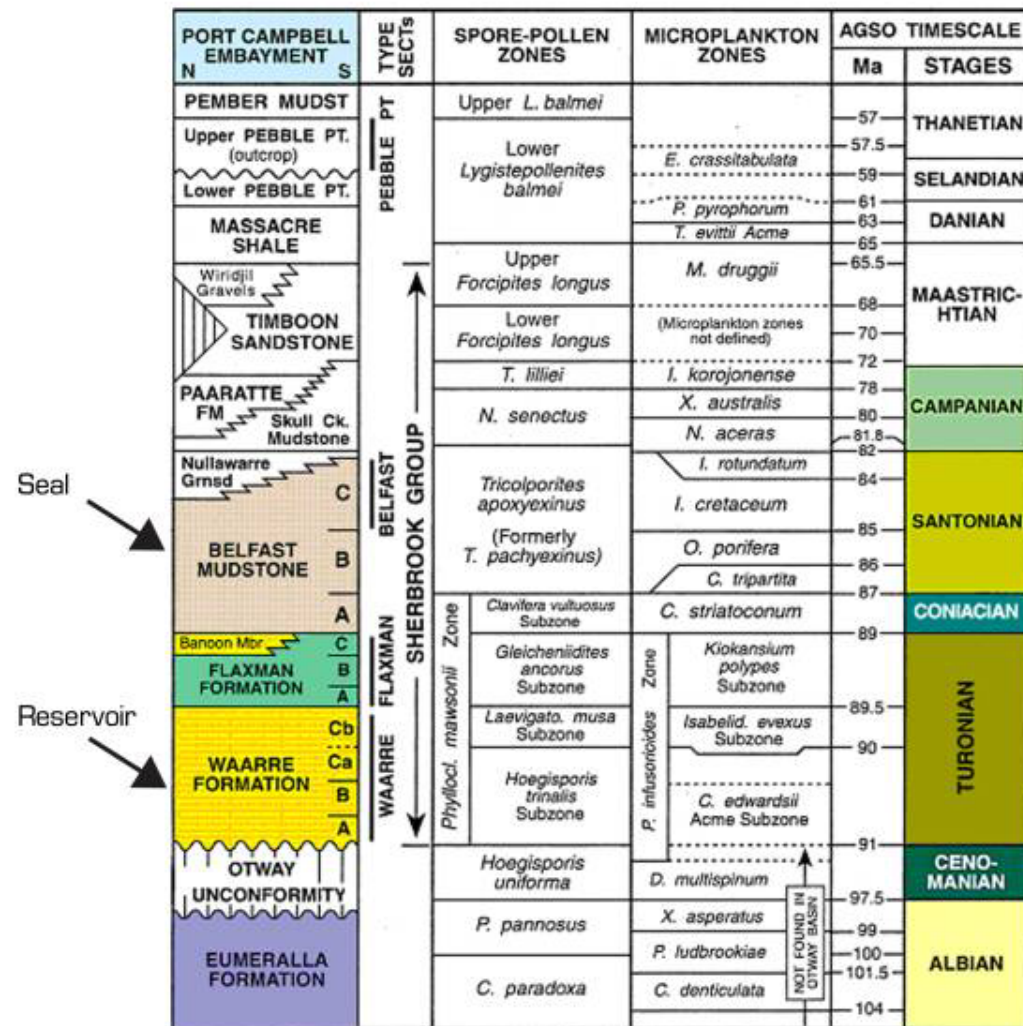
# OBPP Project Processes



# Project Assets and Site

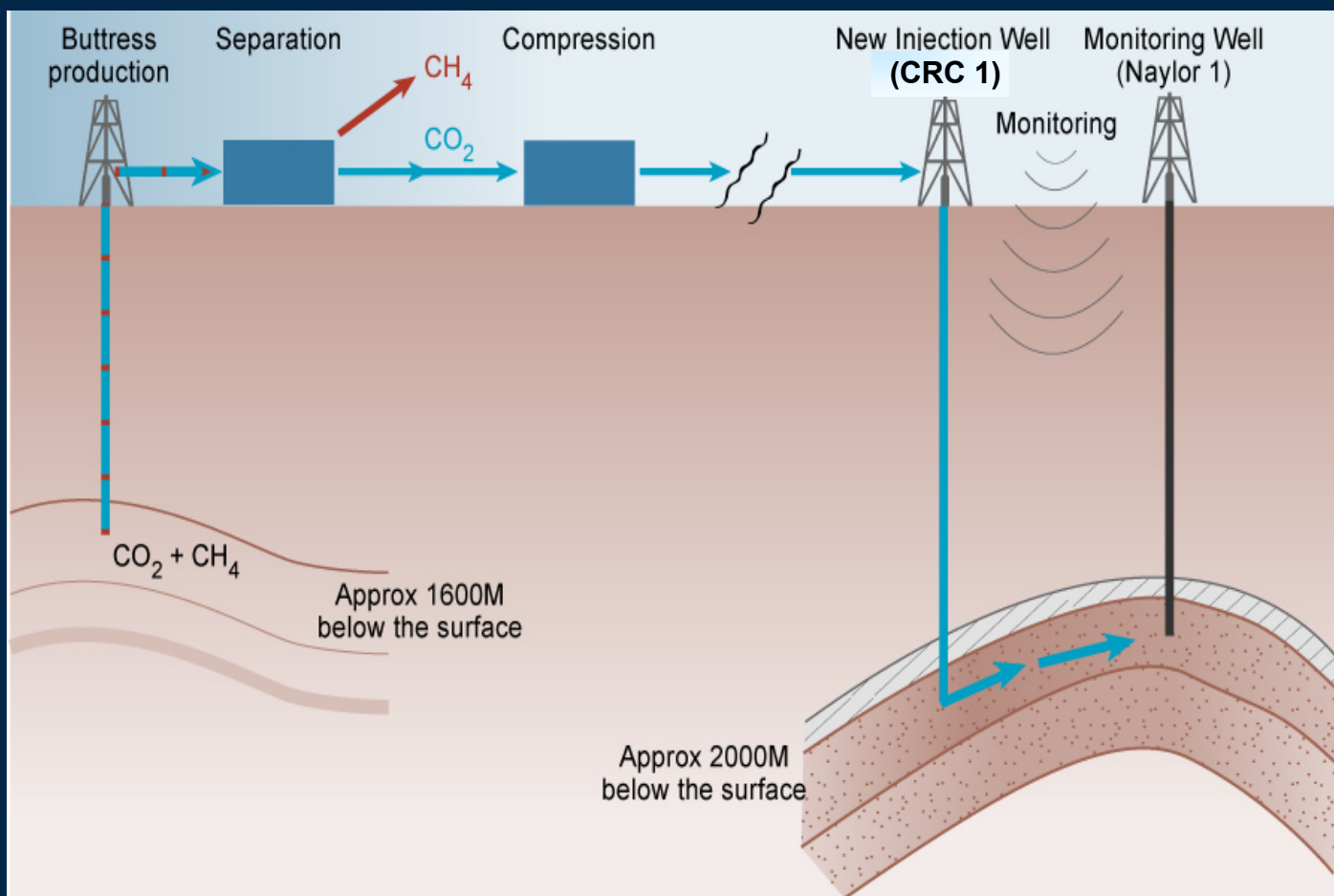


# Favourable Geological Setting



Partridge 2001

# Conceptual Representation of the Pilot Project



- Plan to inject 100,000 tons of CO<sub>2</sub> over 1-2 yrs @3MMSCFD
- Ongoing monitoring program till 2009-10

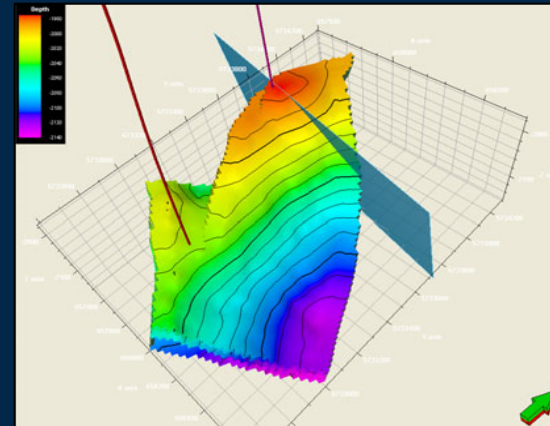
# Technical/Operational Challenges

- Site characterisation
- Constraints from existing wells – size and condition
- Quantification of risk → research
- Monitoring and Verification:
  - Detection and imaging of plume in the presence of residual gas → research
  - Modelling and long term interactions → research
- Other Constraints
  - Budget inflexibility : Funded through grants
  - Industry Resource shortage : Cost and Schedule creep

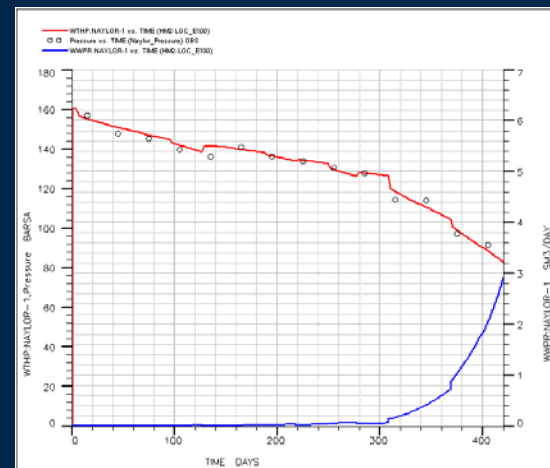
# Reservoir Model

- Rigorous multi-disciplinary approach based on established oil field processes validated through peer reviews.

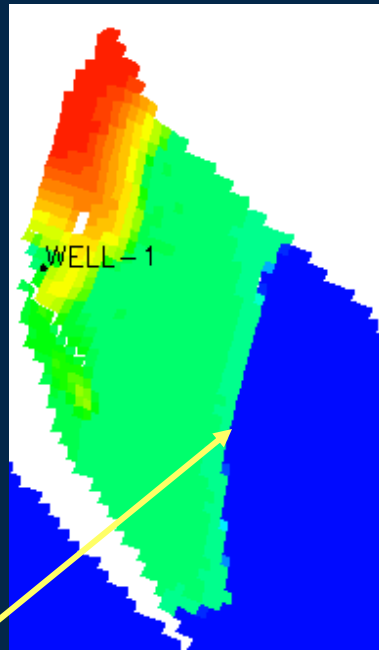
- Build detailed reservoir model for a low sinuosity braided fluvial system.



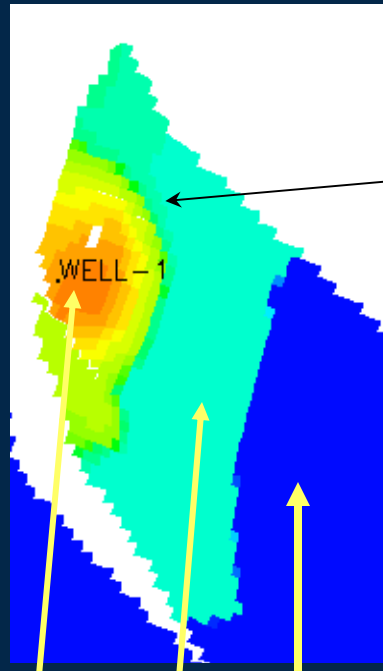
- History match with actual production data to validate model.



# Model Validation through New Data

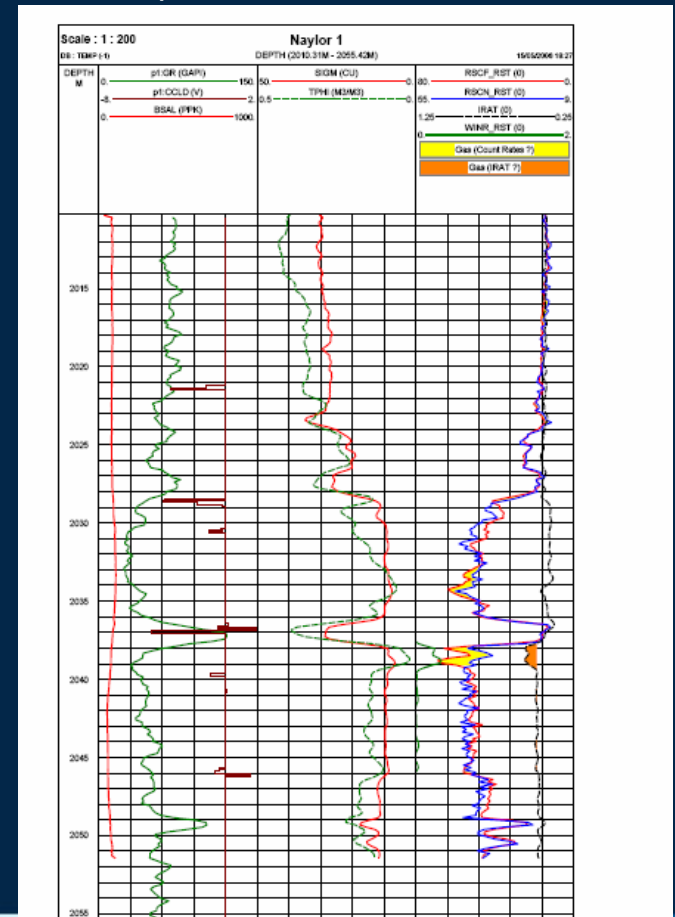


Pre-production GWC,  
2020 m S.S.



Current GWC, 1990 m  
S.S.  
(2040 m R.T.)

1. Gas cap
2. Trapped gas ( $S_{gr}=0.25$ )
3. Aquifer (partial)



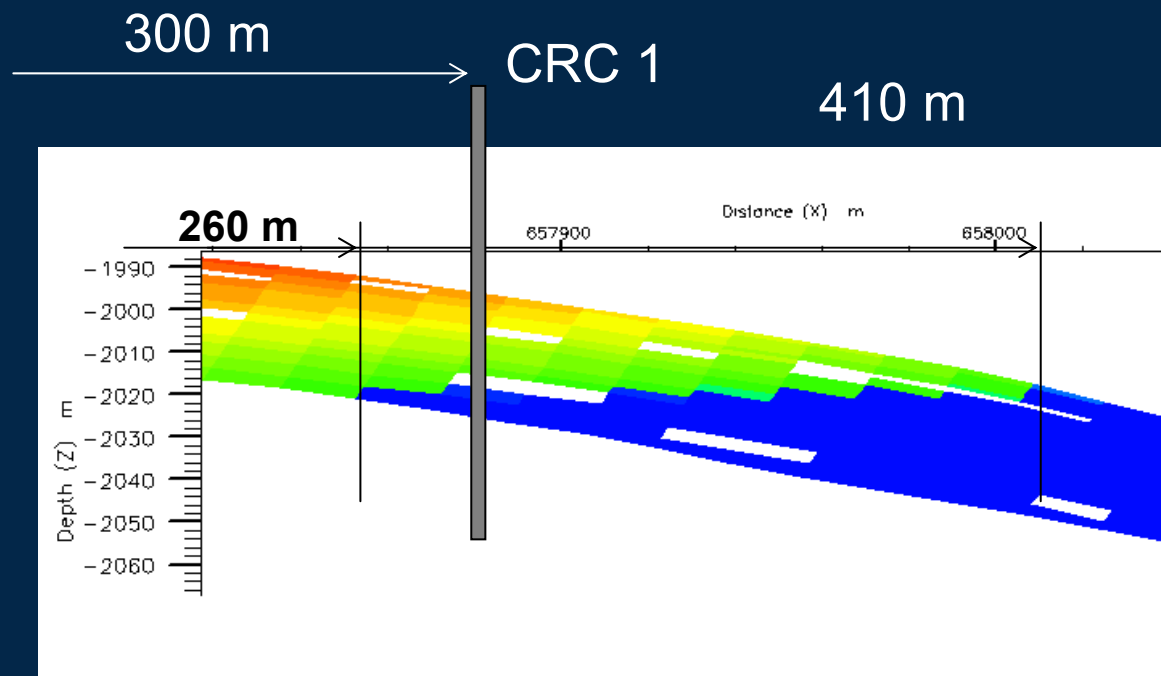
# New Well Location

## 1. Encounter the pre-production GWC

Injection in the water leg (monitoring considerations)

Confirmation of (e.g., through RST) the pre-production GWC

## 2. Reasonable time (6 –9 months) for CO<sub>2</sub> arrival at observation well



# Well Test and CO<sub>2</sub>-CH<sub>4</sub> Phase Behavior



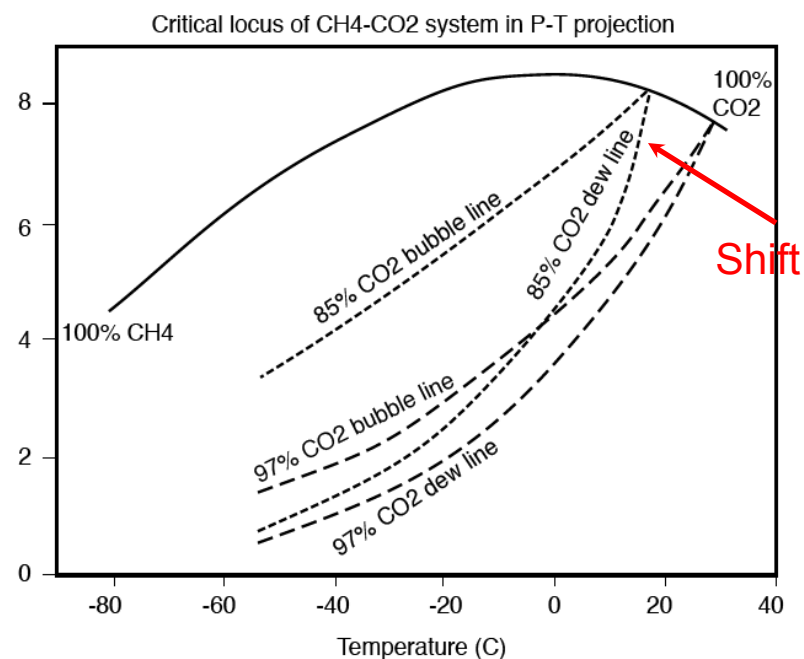
1314psi wellhead pressure  
+25 degC wellhead temperature upstream  
-23 degC flare line temperature

CO<sub>2</sub> 78.72 Mol%

C1 18.76 Mol%

No H<sub>2</sub>S, Hg...

Critical point (PR EoS):  
8.5 MPa (1250 psi)  
14.9 °C



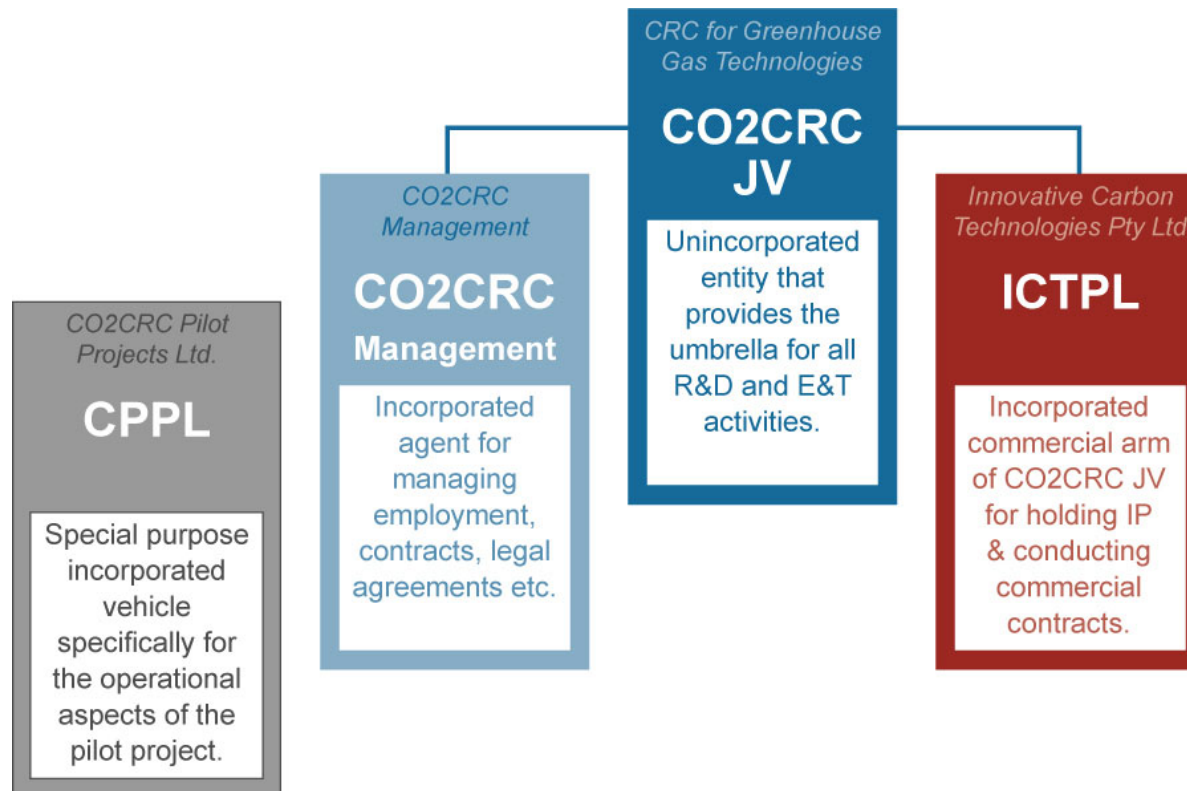
# OBPP Risk Assessment

- Qualitative RA at time of Evaluation of Assets
- Detailed risk assessment as project developed
  - Planning and pre-implementation risks
  - Implementation risks
  - Long-term storage risks
    - Leakage to surface from reservoir
    - Leakage to surface via wells
    - Leakage into potable water aquifers
- QRA-containment: Post-static modelling and simulation
- Next QRA: Pre Injection
- No other pilot site had full QRA undertaken prior to injection

# Non-Technical Challenges

- **Regulatory**
  - No existing regulation for geo-sequestration.
- **Organisational**
  - CRC not an operating entity with a defined life span
  - Not all CRC participants able to shoulder operational liability
- **Liability Management**
  - Research Project: Operational Liability not offset by project NPV.
  - Need for a solution to long term liability.
- **Community**
  - First of its kind with no national precedent
  - Mixed reports in media

# Special Company for Project Execution



# Monitoring and Verification

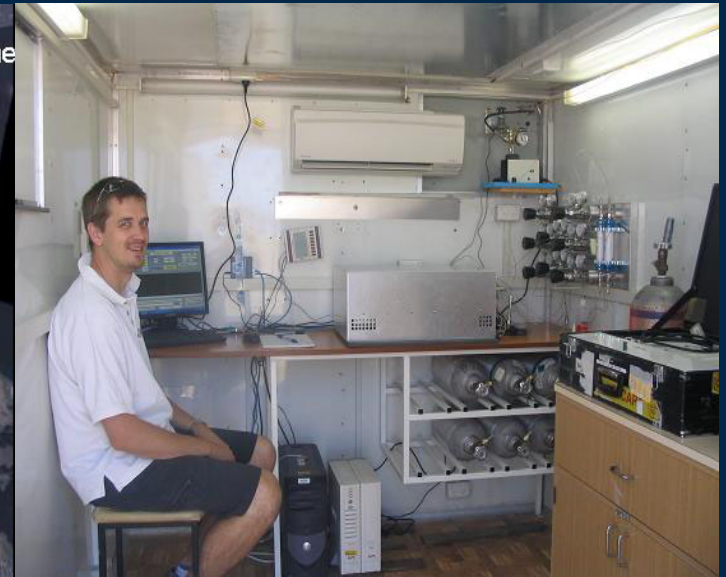
- **Assurance Monitoring (no leakage)**
  - Soil and atmospheric measurements to confirm non leakage/seepage of injected CO<sub>2</sub>.
  - Hydrogeological monitoring to ensure no leakage of CO<sub>2</sub> into the overlying aquifers
- **Storage Integrity Monitoring (predicted behaviour)**
  - Monitor the injected CO<sub>2</sub> plume to :
    - Validate migration paths
    - Validate migration times
    - Validate likely shape
    - Validate geomechanical integrity
    - geophysics
    - geochemistry /tracers
    - reservoir properties
    - coupled models

# Atmospheric Monitoring

Monitor CO<sub>2</sub> in the atmosphere and define the sources



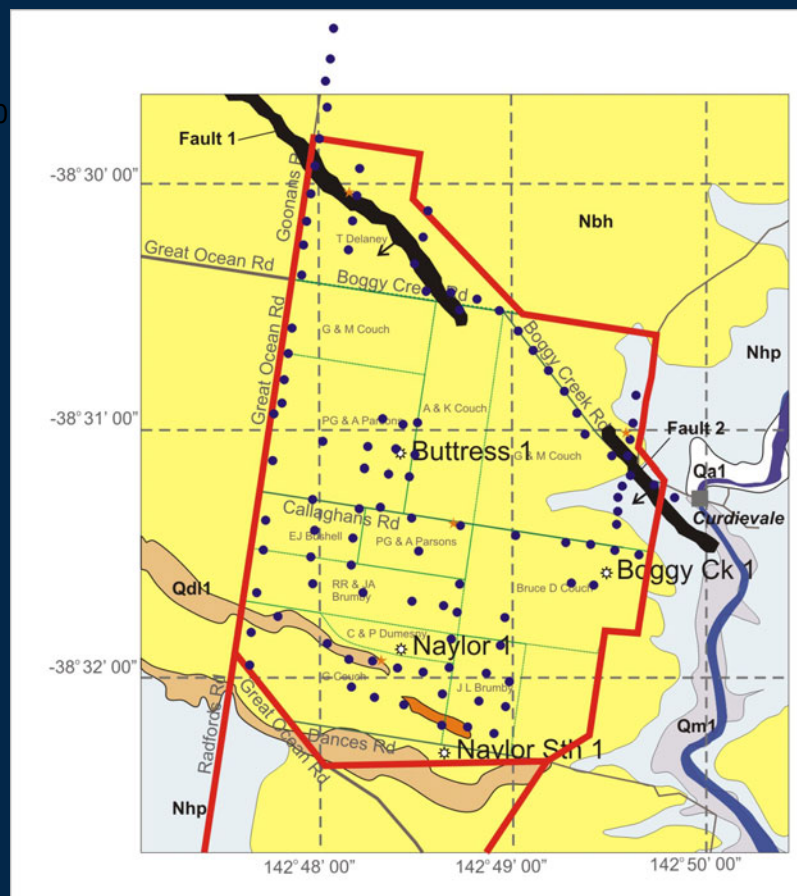
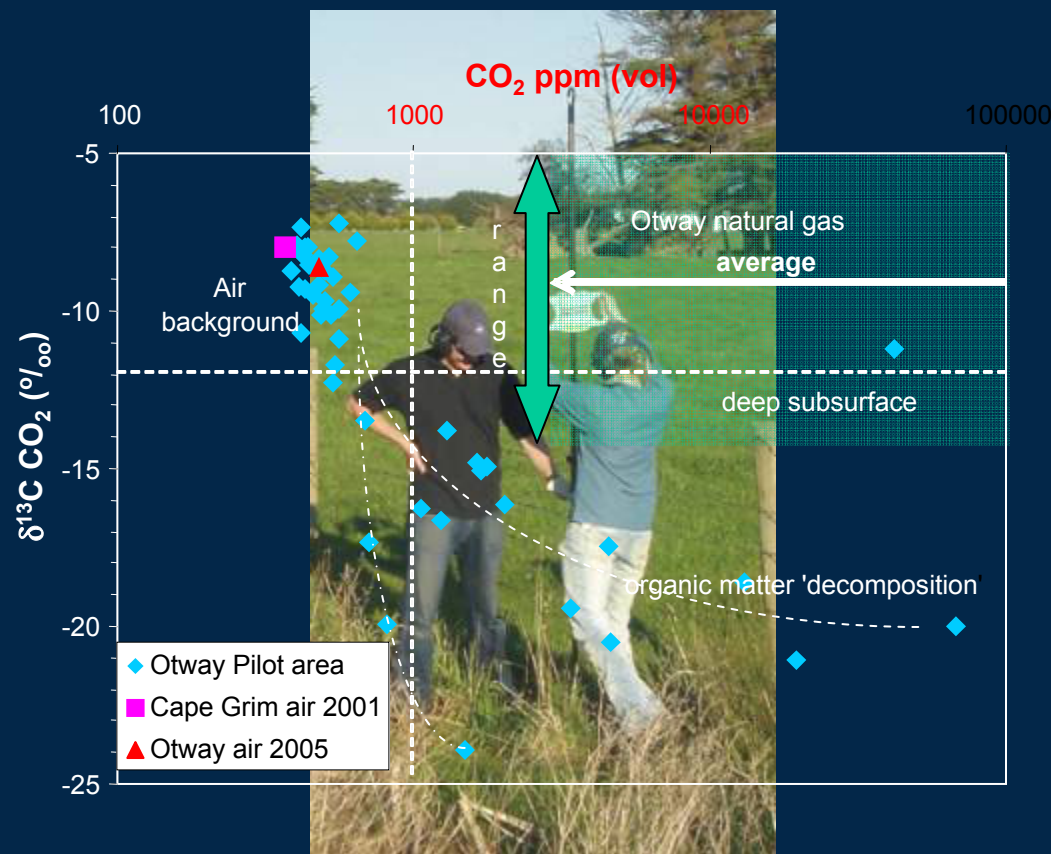
Flux Tower



Lo-Flo\*

# Soil Gas and Water Well Sampling

Monitor soil gas to define near surface CO<sub>2</sub> movement.



- Strong “biological signature”

# Monitoring: Rock physics sensitivity modeling CO<sub>2</sub> in a depleted gas field

Unknown

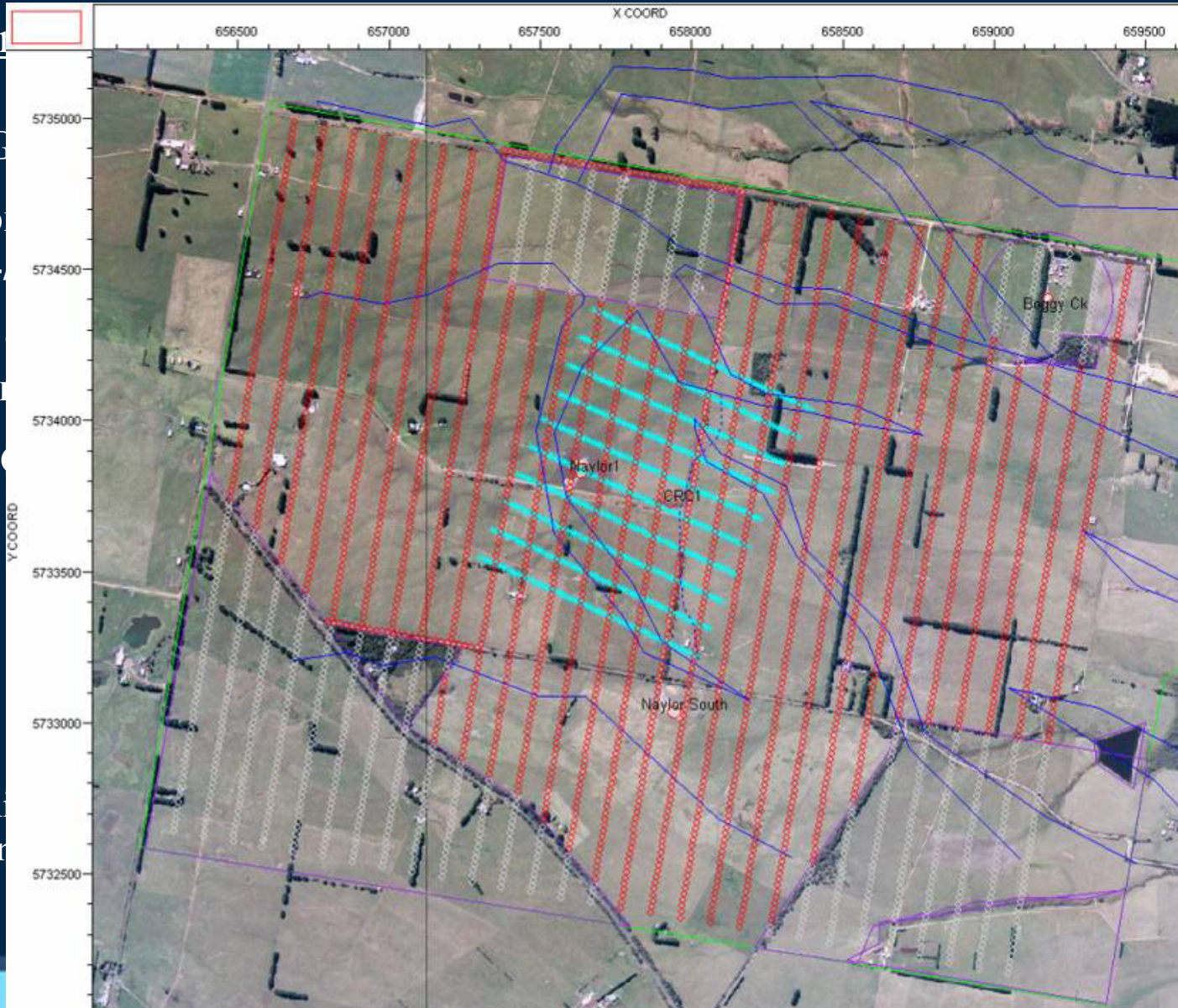
Present C

Transition  
zone CH<sub>4</sub>

Residual  
saturation

Original C

J Xu,  
J. Ennis-K  
L. Paterson

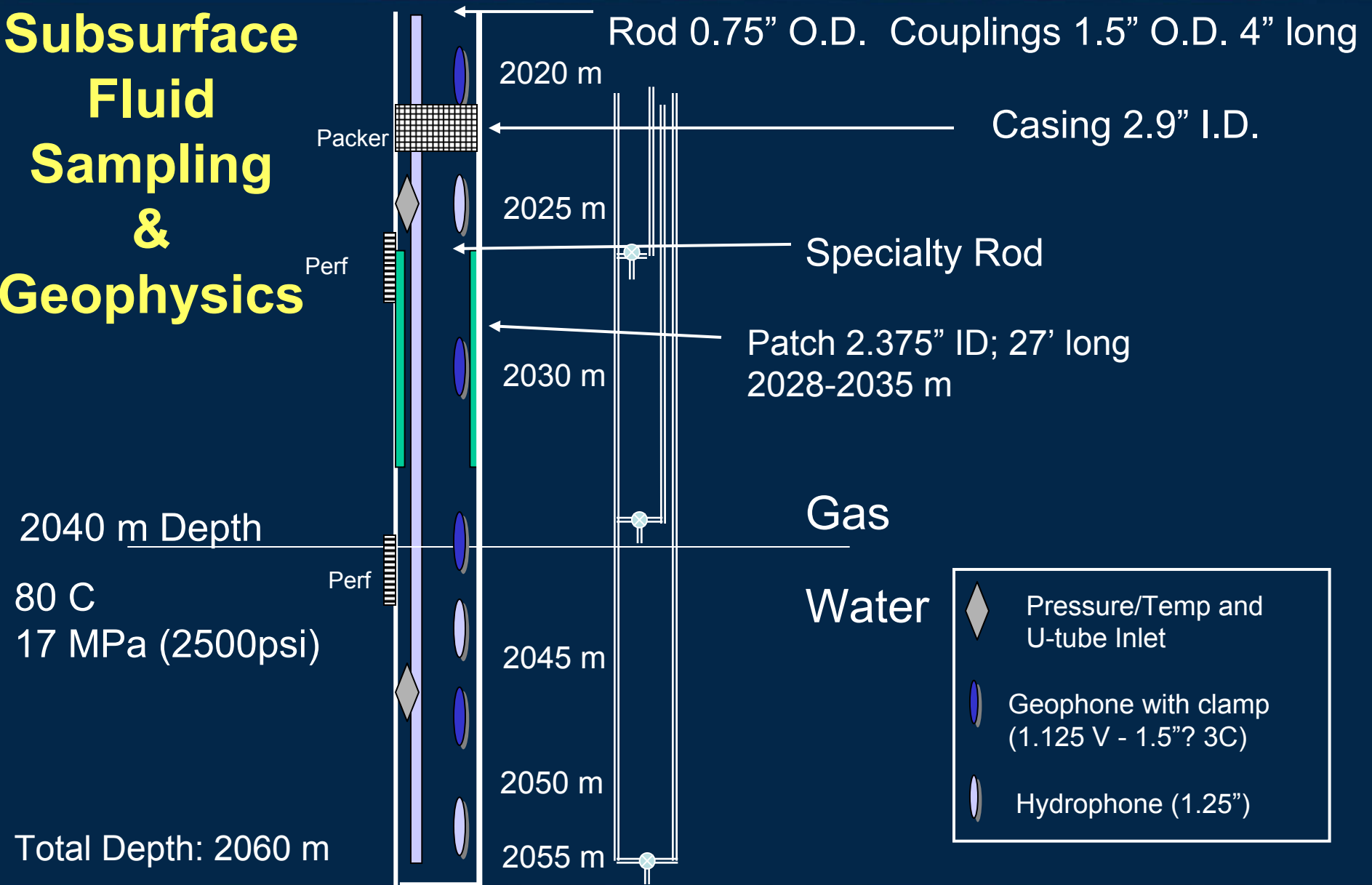


interface(s)

wrt residual  
and mixing

velocity and  
in water leg

# Subsurface Fluid Sampling & Geophysics



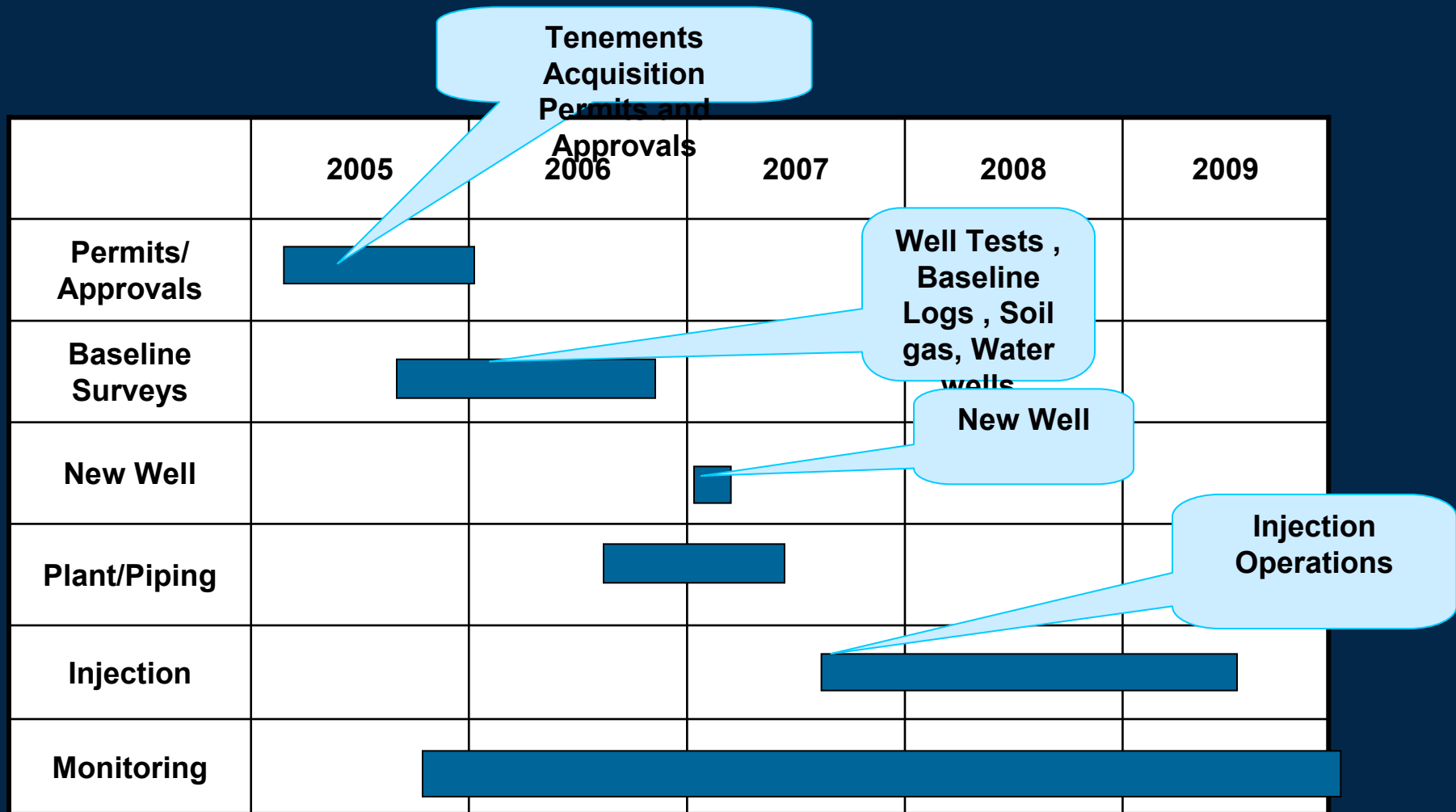
# Community Consultation

- Formal program to engage with the community early – starting Jan 05
  - Key landholders , Shire and neighbouring councils, Local media
  - NGO's, Politicians
- Aim is to establish trust in the Nirranda community.
  - Nirranda residents are always the first to hear new information directly from CO2CRC.
- Invited Mayor and Planning Manager to CRC technical Symposium
- Formal briefing to shire and public
  - Public info packs distributed to 1200 households
  - Advertisements run in local papers
  - Public meeting (together with state regulators) held on February and October 06
- Formation of a stakeholder reference group
  - Meeting (open to public) on May 3, 07
- Social research in community perception

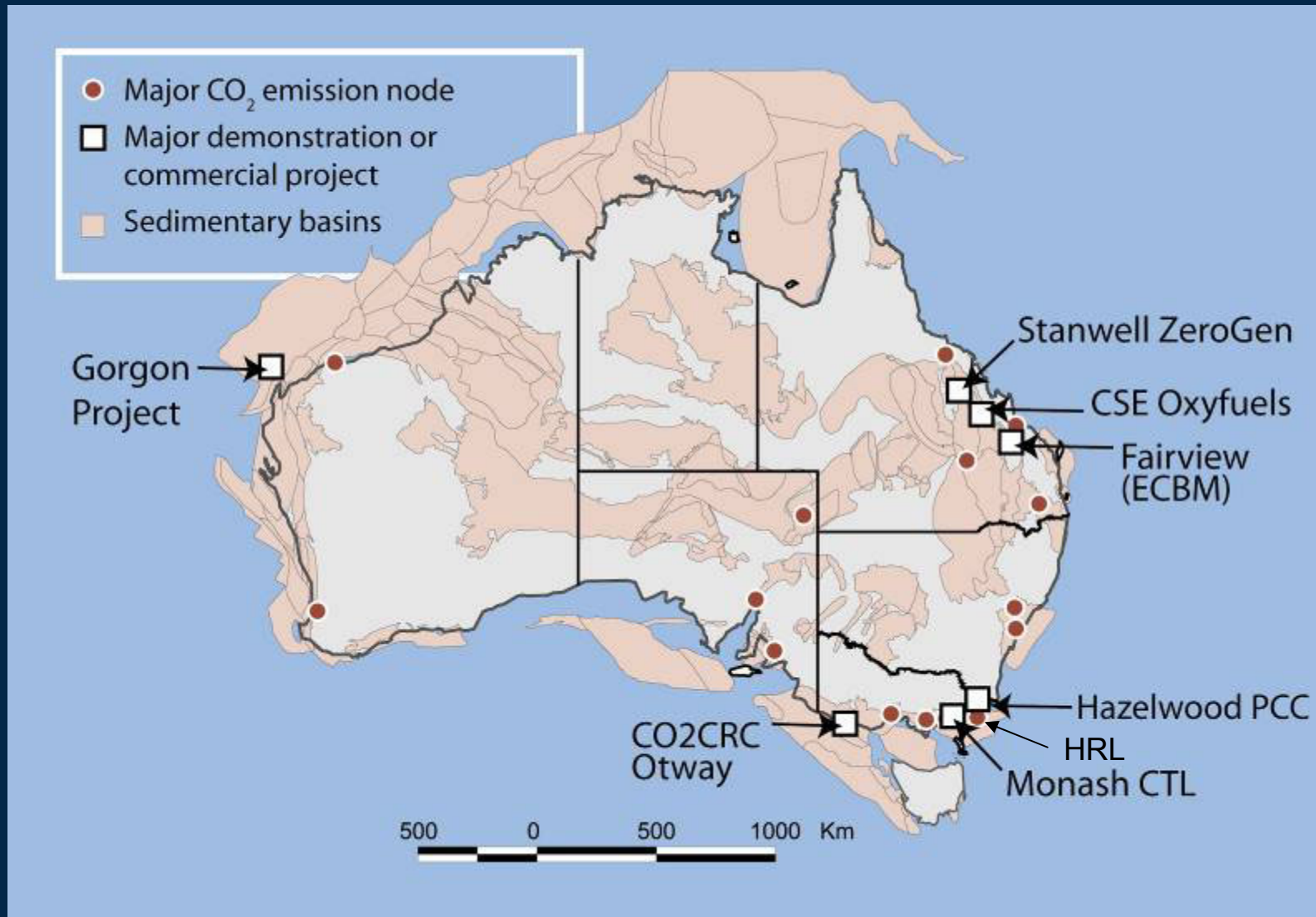
# International Context

	Geological Data Availability		Baseline data	Reservoir Geochem	Geo-physics	Ground water monitoring		Soil Gas	Atmos	Containment Risk Ass. prior to project start
	Regional	Reservoir				Hydrology	Geochem			
<b>West Texas</b>		Largely confidential		very limited	limited					
<b>Alberta Basin</b>		limited		very limited						
<b>Sleipner</b>		limited	limited							
<b>Weyburn</b>		Largely confidential						limited		
<b>Frio</b>						limited	limited	limited		
<b>Japanese</b>										
<b>OBPP</b>										

# Pilot Project Timeline



# CCS Projects in Australia



# **Australia's First Geosequestration Demonstration - The CO2CRC Otway Basin Pilot Project**

**6<sup>th</sup> Annual Conference on Carbon Capture and Sequestration  
Pittsburgh , May 10, 2007**

Sandeep Sharma<sup>1,2</sup>, Peter Cook<sup>1</sup>

<sup>1</sup> Cooperative Research Centre for Greenhouse Gas Technologies, Canberra,  
ACT 2601, Australia.

<sup>2</sup> Schlumberger Australia, Pty. Ltd., Perth, WA 6000, Australia.